A.D. 1860, *10th October.* N° 2462.

Electro-magnetic Telegraphs, &c.

LETTERS PATENT to Charles Wheatstone, of Hammersmith, in the County of Middlesex, Gentleman, for the Invention of "IMPROVEMENTS IN ELECTRO-MAGNETIC TELEGRAPHS AND APPARATUS FOR TRANSMITTING SIGNS OR INDICATIONS TO DISTANT PLACES BY MEANS OF ELECTRICITY, AND IN THE MEANS OF AND APPARATUS FOR ESTABLISHING ELECTRIC TELEGRAPHIC COMMUNICATION BETWEEN DISTANT PLACES."

Sealed the 15th March 1861, and dated the 10th October 1860.

PROVISIONAL SPECIFICATION left by the said Charles Wheatstone at the Office of the Commissioners of Patents, with his Petition, on the 10th October 1860.

I, CHARLES WHEATSTONE, of Hammersmith, in the County of Middlesex, Gentleman, do hereby declare the nature of the said Invention for the Invention of "IMPROVEMENTS IN ELECTRO-MAGNETIC TELEGRAPHS AND APPARATUS FOR TRANSMITTING SIGNS OR INDICATIONS TO DISTANT PLACES BY MEANS OF ELECTRICITY, AND IN THE MEANS OF AND APPARATUS FOR ESTABLISHING ELECTRIC TELEGRAPHIC COMMUNICATION BETWEEN DISTANT PLACES," to be as follows:—

The first improvement consists of a modification of the communicator described as the sixth improvement in the Specification of the Patent, No. 1241 granted to me on the second of June 1858.

In this modification the magneto-electric machine is dispensed with, and an apparatus similar to that described as part of the fourth improvement of the same Patent is connected with the axis which carries the index for the purpose

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of alternating the direction of the currents proceeding from a voltaic battery placed in the circuit. The axis carrying the index is caused to rotate, and the apparatus producing the inversion of the currents is brought into play by a motion communicated to the axis by means of appropriate gearing from a winch moved by the hand or from any maintaining power. As in the case of the aforesaid fourth improvement this arrangement is either adapted for working the step by step telegraphs when the direct current of a voltaic battery is employed, or is so modified as to permit the employment of induction currents originated by a voltaic battery.

The second improvement consists in a new construction of the communicator to be employed in communication with a voltaic battery, when, as in the preceding case, either the direct current or the secondary current from the induced circuit is to act on the telegraphic instruments.

The object of this improvement is to determine the number of alternately inverted currents requisite to cause the index of the telegraph to point to the proper letter or sign by means of the pressure of finger stops without having recourse to any maintaining power as a spring, or weight, or motion of the hand for the purpose. The finger stops or keys are circularly arranged round a central axis, carrying on its upper end an index which, as the axis rotates, points to different characters on a letter circle. A portion of this axis consists of an endless screw which is acted upon to cause the rotation of the axis by any one of several levers placed so as to press upon the thread of the screw in a direction parallel to the axis; the ends of the levers more distant from the axis are sufficiently broad to allow several finger keys separately to press upon each of them. The lower part of each key is furnished with a pin; these pins are radially arranged from each key towards the centre. The axis carrying the endless screw is also furnished with a pin or stop placed below the plane of the pins attached to the keys. On pressing down a key a lever presses on the screw, and causes the axis and consequently the index to rotate until the stop on the axis comes against the depressed pin of the key, and thus the motion is arrested when the index is opposite to the letter corresponding to the depressed key. The lower part of the axis is connected with an apparatus for alternately inverting the current similar to that of the communicator already mentioned as the first improvement. Instead of a screw the axis may carry a pinion with ratchet leaves, which s caused to rotate by any one of several racks in gear with the pinion; the extent of motion of these racks is determined by the keys in a similar manner to that already described when the screw is employed. When the key is released the rack recedes by means of a spring to its original position.

The third improvement consists in a new construction of the magneto-electric machine. Two soft iron cores with their coils are fixed to each pole of a permanent magnet, so that the centres of their unfixed ends are equi-distant from each other in the circumference of a circle. An axis passing through the centre of this circle carries a soft iron armature, the breadth of which is a little greater than the distance between two adjacent cores. The wires of the coils are so connected together that the currents produced simultaneously in each coil, two by the approach and two by the recession of the armature to and from the soft iron cores, all concur to produce a current in the same direction in the communicating wire, and during one revolution of the armature four shocks, or instantaneous currents are successively produced at equal intervals, each successive shock being in the opposite direction to the preceding. Several magnets of this description may be combined to form a compound magneto-electric machine. The magnets are placed so that the axis carrying the armatures are vertical and arranged at equal distances in a circle. Each of these axes are furnished with a pinion, and all the pinions gear into a wheel fixed on an axis, which is connected by means of multiplying wheels with the handle. The position of the armatures may be so varied that the shocks produced by all the magnets may be simultaneous or they may be successive; thus, when the machine is composed of four magnets according to different arrangements of the positions of the armatures, four, eight, or sixteen currents may be obtained during one revolution of the central axis.

The fourth improvement consists in substituting for a voltaic battery a magneto-electric machine, either simple or compound, (that is, either consisting of one or of several magnets and armatures), kept in continual motion by the action of a constant force for the purpose of ringing any number of electro-magnetic bells any where placed in an establishment. For this object one end of the magneto-electric coil is placed in connexion with the earth; from any points of a conducting wire attached to the other end of the coil, wires proceed to the touches or connecting apparatuses of all the bells; other wires also proceed from the touches to a conducting wire immediately connected with the earth. When the touch corresponding to any bell is acted upon its two wires are brought into contact, the circuit is thereby completed through the branch containing the bell, the magneto-electric current circulates and the bell rings. It will be found in some cases more convenient to suppress the earth communications, and to join the two main conducting wires at their extremities; in this case the circuit when formed will be entirely metallic.

The fifth improvement is a magneto-electric apparatus for ringing an electro-

magnetic bell at a distance, so constructed that a single motion of a lever or a single pull of a rope or wire causes several currents to be produced in succession, in order to act repeatedly on the electro-magnet moving the clapper of a bell or the detent of the alarum described as the eleventh improvement in the Specification of the Patent, No. 1241, granted to me on June the Second 1858. The lever is connected with the rotating armature of the magneto-electric machine by means of a chain or band, which causes it to make several revolutions by a single motion of the lever, and a spring reverses the motion immediately the armature ceases to act.

The sixth improvement consists in the employment of musical pipes, or free tongues, (such as employed in the concertina, harmonium, & other similar instruments), acted upon by wind for the purpose of communicating intelligence by means of audible instead of visible signs. I prefer to employ pipes or tongues producing very high sounds, since they require a much less quantity of wind than lower sounds. The passage between the reservoir of air and the pipe or tongue is closed by a valve, which when acted upon by an electro-magnet opens and allows the passage of the wind to the pipe or tongue. The reservoir of air may be either a small gasometer, a water blow-pipe, an india rubber ball collapsing by its own elasticity, or a bag impermeable to air compressed by a weight or spring; the air being in all these cases restored when exhausted by blowing through a pipe furnished with a throttle valve, or by other means; or a bellows of any description kept in action by a maintaining power may be employed for this purpose. With this apparatus long and short sounds may be made to follow each other in the successions constituting the letters of Morse's telegraph. Two such pipes or tongues producing different notes connected with the same or separate reservoirs, the valve of one acted upon when the current proceeds in one direction, and the valve of the other when the current proceeds in the opposite direction constitutes a telephone, of which the alphabet may correspond with that of the usual single needle telegraph.

The seventh improvement is a modification of that part of my automatic printing telegraph, which is called the transmitter, and is described as the second improvement in the Specification of the Patent, No. 1239, granted to me, and dated June Second, 1858. The object of this modification is to enable the transmitter by means of the perforated slips of paper, therein described, to act upon the receiving instruments of a Morse's telegraph in such manner as to impress on bands of paper in any required order the successions of long and short marks in the same line, which constitute the alphabet of that telegraph instead of the double row of dots required in my system. For this purpose a

slight change only in the mechanism is necessary. The contacts made by the external wires of the rocking frame are so disposed that whether one or the other be depressed the current is transmitted to the telegraphic wire in the same direction instead of in opposite directions, as is the case in the former construction. The eccentric which effects the elevation and depression of the wires acts differently upon them, so that the duration of the contact of one wire lasts longer than that of the other. When the slip of perforated paper is inserted in the groove of the rocking frame of the transmitter, and the instrument is put in action, whenever the end of one of the wires enters an aperture in its corresponding row the current has a shorter duration; and whenever the end of the other wire enters an aperture of the other row it has a longer duration; by the appropriate arrangement of apertures in the slip of paper long and short currents are thereby made to succeed each other in the proper order to mark on the recording or receiving instrument the letters of what is termed the Morse alphabet.

The eighth improvement is a telegraphic thermometer, which communicates to a distant place notice of the two limits of its indications. Its construction is as follows:—A segment of a circle graduated so as to include the two limits of temperature intended to be indicated is fixed on an insulating board. Two arms move separately round a pin at the centre of the circle; the longer ends of these arms serve as pointers to be set at the required degrees of the graduated circle; the shorter ends carry pins, in which adjusting screws are inserted. A compound metallic bar consisting of long strips of iron and brass, or other two dissimilar metals soldered together face to face is fixed at one end to the board, so that its edge is perpendicular thereto; the free end of this bar is placed between the pins on the shorter ends of the arms, and the distances of the latter are so adjusted by means of the screws, that when the extremes of temperature to which the arms are set act upon the compound bar, it shall come in contact with one of them; a binding screw is in communication with the metallic arms of the circle, and another with the fixed end of the compound bar. The terminals of a voltaic circuit, including a voltaic battery, and an electro-magnetic bell are attached to the two binding screws. So long as the unfixed end of the compound bar is entirely free the circuit remains open, but when the action of temperature brings it into contact with either pin the circuit is completed, the voltaic battery is brought into activity, and the bell rings. Instead of a straight bar, a compound bar formed into a helix, as in Brequet's metallic thermometer, and carrying at its unfixed end a pointer may be substituted; pins, moveable for the purpose of being set at determinate degrees, are placed on the graduated circle, and the contact

of the pointer with either of these pins determines the completion of the circuit.

The ninth improvement consists of a new system of establishing lines of telegraphic communication over the houses, or along the streets of cities & towns at present; naked iron or steel wires are stretched between posts at certain distances apart, supplied with straining apparatus and intermediate posts are placed for supporting while preserving the insulation of the wires. The chief disadvantages of this system are, first, the great danger of contacts between wires which cross each other in various directions; secondly, the great expense when the number of wires is considerable; and thirdly, the liability to loss of insulation in wet weather. In the proposed system, straining posts elevated at the tops of public buildings or private houses are fixed at distances about a mile apart, and their positions are so arranged that when they are joined by straight lines a series of triangles as nearly approaching equilateral as may be found convenient is mapped out. From these straining posts, in six different directions nearly equidistant from each other, two steel or galvanized iron wires are stretched in the same horizontal plane to all the posts about a mile distant from it, and their tension is maintained by straining apparatus. A single strong wire will suffice, but greater security will be ensured by employing two. Intermediate supporting posts, but which require no insulating apparatus, as these wires are not for the purpose of transmitting electricity, are fixed at convenient distances. A rope consisting of a bundle of metallic wires (say, from 20 to 60), each having a separate covering of india-rubber, gutta percha, or other good insulating material is suspended from these two wires at short intervals along their entire lengths. The ropes terminate at the straining posts, and the free ends of all the wires contained therein are brought into a box, which forms part of or is placed in connection with the post; by means of metallic connections within the box the wires proceeding from one direction may be united to those proceeding in any other direction, and thus the wires may be combined in every possible manner, and the combinations changed as required. From these connecting stations also the single wires proceed, which complete the communication between the main lines, and the establishments to be placed in connection with them. It is not necessary to cover the whole of a town with triangulations, as above described, they may be extended only to those parts of the town where telegraphic communication will be profitable, and they may also be intermitted where other means of carrying the rope may be more convenient or economical. In particular cases the following methods of suspending the rope of wires will be found advantageous; secondly, iron posts of considerable elevation are to be erected in the

streets in positions ordinarily occupied by lamp posts; these are for the purpose of straining and supporting two steel or iron wires, as in the first method, and the rope of wires is to be suspended from them in a similar manner. When two or more streets intersect each other, and it is necessary that lines should proceed through several or all of them, the ends of all the ropes terminating at that post must pass down it, so that the wires contained in them may be there connected in any ways that may be required; thirdly, iron rods or wires are laid at convenient distances from each other transversally across streets, so that the ends of each shall be fixed on the tops or against the front walls of houses opposite each other. Each of these rods or wires is furnished with a ring or eye fixed to some part of its length where it passes over the street, and the rope containing the insulated telegraphic wires passes through these rings or eyes; to diminish the swag of the rope a tightening screw is adapted to each suspending ring for the purpose of grasping it. When it is required to form a connecting station the transverse rod or wire must be provided with two or more rings or eyes to receive the ropes proceeding from different directions; the ends of all the ropes must be led along the rod, and thence into a room of an adjacent house; or they may be let down covered by a protecting tube outside the house to a connecting box placed against the wall. It will be more advantageous, for many obvious reasons, to conduct the telegraph line when this method is adopted through narrow streets than through the leading thoroughfares. The common feature in all these methods is that of supporting ropes, each containing a number of insulated wires in the air, along streets, or over the roofs of houses, and so bringing the ends of the wires belonging to a rope proceeding from one direction in juxtaposition with those proceeding from other directions, that they may be combined to form continuous lengths through a variety of different routes, so as to be capable of forming an uninterrupted communication in several ways from any one point to another in the system.

The tenth improvement is a method of constructing the supports of suspended telegraphic wires, which has the advantage of preventing in a great measure the communication of sound and vibratory motions arising from the action of wind. This object is effected by interposing a cylinder of vulcanized india-rubber between the support and the insulating apparatus of the telegraphic wires. This method is equally applicable to the suspending wires carrying the rope of conductors, described in the preceding article, but in this case no insulations are required.

SPECIFICATION in pursuance of the conditions of the Letters Patent, filed by the said Charles Wheatstone, in the Great Seal Patent Office on the 10th April 1861.

TO ALL TO WHOM THESE PRESENTS SHALL COME, I, Charles Wheatstone, of Hammersmith, in the County of Middlesex, send greeting.

WHEREAS Her most Excellent Majesty Queen Victoria, by Her Letters Patent, bearing date the Tenth day of October, in the year of our Lord One thousand eight hundred and sixty, in the twenty-fourth year of Her reign, did, for Herself, Her heirs and successors, give and grant unto me, the said Charles Wheatstone, Her special licence that I, the said Charles Wheatstone, my executors, administrators, and assigns, or such others as I, the said Charles Wheatstone, my executors, administrators, and assigns, should at any time agree with, and no others, from time to time and at all times thereafter during the term therein expressed, should and lawfully might make, use, exercise, and vend, within the United Kingdom of Great Britain and Ireland, the Channel Islands, and Isle of Man, an Invention for "Improvements in Electro-magnetic Telegraphs and Apparatus for Transmitting Signs or Indications to Distant Places by Means of Electricity, and in the Means of and Apparatus for Establishing Electric Telegraphic Communication between Distant Places," upon the condition (amongst others) that I, the said Charles Wheatstone, my executors or administrators, by an instrument in writing under my, or their, or one of their hands and seals, should particularly describe and ascertain the nature of the said Invention, and in what manner the same was to be performed, and cause the same to be filed in the Great Seal Patent Office within six calendar months next and immediately after the date of the said Letters Patent.

NOW KNOW YE, that I, the said Charles Wheatstone, do hereby declare the nature of the said Invention, and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

The first improvement consists of a modification of the communicator described as the sixth improvement in the Specification of the Patent No. 1241, granted to me on the Second day of June 1858. In this modification the magneto-electric machine is dispensed with, and an apparatus similar to that described as part of the fourth improvement of the same Patent is connected with the axis, which carries the index for the purpose of alternating the direction of the currents proceeding from a voltaic battery placed in the circuit, the axis carrying the index is caused to rotate and the apparatus producing the

inversion of the current is brought into play by a motion communicated to the axis by means of appropriate gearing from a winch moved by the hand or from any maintaining power. As in the case of the aforesaid fourth improvement the arrangement is equally adapted for working the step by step telegraph when the direct current of a voltaic battery is employed, or when induction currents originated by a voltaic battery are made use of. Figure 5 (Sheet 1,) represents a plan and elevation of this modification in the communicator, in place of the driving wheel on the axis for moving the armature of the magnet, a current changing wheel *a*, as described in the fourth improvement of my Patent No. 1241, dated Second day of June 1858, is attached alternately, inverting the current from a voltaic battery in the revolution of the axis *b*. By means of appropriate gearing, the axis carrying the index is caused to rotate, and the apparatus producing the inversion of the currents necessary for the step by step motion of the telegraphs brought into play. Another form of apparatus for producing the inversion of the currents proceeding from a voltaic battery placed in circuit, is shown at Figure 8, (Sheet 1). *a* and *b* are two brass pillars supporting an insulating plate of ebonite, in which are fixed six metal binding screws 1, 2, 3, 4, 5, 6. A vertical axis carries a small fly wheel *c* and pinion *d*, and at its upper end a circular disc, at the circumference of which is attached two ebonite links *e* and *f*, moving freely round their common axis; the other ends of these links are attached respectively to two brass arms, which have the pins of the binding screws 2 and 5 for their axes, and each carries a cross piece terminating with springs, which, during the motion of the instrument press alternately against the binding screws 1 and 3, and 4 and 6. The distances of the springs *s*, and pins are so adjusted, that each contact lasts during, about, one-fourth of a revolution of the eccentric. The multiplying wheel *g* is connected with the axis carrying the index, or, when the apparatus with finger keys is dispensed with, is provided with a handle or index *h* for the purpose of setting it in motion. When the wheel *g* is turned the eccentric is caused to revolve rapidly and in consequence of the arrangements above described, the binding screws 2 and 5 respectively in connection with the earth and line wire are brought alternately in rapid succession in metallic contact, the former with the binding screws 1 and 3, and the latter with 4 and 6, in connection with the poles of a voltaic battery, by which means the inversion of the currents is produced. This arrangement also permits the employment of induction currents originated by a voltaic battery, by arranging the terminal wires of the primary and secondary coils of the induction apparatus and those of the telegraphic circuit

in the manner described in the fourth improvement of the Patent No. 1241, above referred to.

The second improvement consists in a new construction of the communicator to be employed in connection with a voltaic battery, when, as in the preceding case, either the direct current or the secondary current from the induced circuit is to act on the telegraphic instruments. The object of this improvement is to determine the number of alternately inverted currents, requisite to cause the index of the telegraph to point to the proper letter or sign by means of the pressure of finger stops, without having recourse to any maintaining power, as a spring, or weight, or motion of the hand for the purpose. The finger stops or keys are circularly arranged round a central axis carrying on its upper end an index, which, as the axis rotates points to different characters on a letter circle. A portion of this axis consists of an endless screw, which is acted upon to cause the rotation of the axis by any one of several levers placed so as to press upon the thread of the screw in a direction parallel to the axis; the ends of the levers more distant from the axis are sufficiently broad to allow several finger keys separately to press upon each of them. The lower part of each key is furnished with a pin, these pins are radially arranged from each key towards the centre, the axis carrying the endless screw is also furnished with a pin or stop placed below the plane of the pins attached to the keys. On pressing down a key a lever presses on the screw and causes the axis, and consequently the index, to rotate until the stop on the axis comes against the depressed pin of the key, and thus the motion is arrested when the index is opposite to the letter corresponding to the depressed key. The lower part of the axis is connected with an apparatus for alternately inverting the current, similar to that of the communicator already mentioned as the first improvement of the present Patent. Instead of a screw the axis may carry a pinion with ratchet leaves, which is caused to rotate by any one of several racks in gear with the pinion, the extent of motion of these racks is determined by the keys in a similar manner to that already described, when the screw is employed; when the key is released the rack receeds by means of a spring to its original position.

The following is a more complete description of the latter mode of construction. Figure 1 (Sheet 1,) is a side view; Figure 2 is a plan; Figure 3, an under side view; and Figure 4, a vertical section of an apparatus constructed according to this improvement.

a is a plate pierced to receive the several stops or finger keys *b*, the extremities of these stops pass through a second plate *c* attached to the plate *a*

by pillars *d*. An opening in the centre of both plates admits of the passage of the central axis *e* carrying on its upper end an index *f*; *g*, *g*, are stop plates working upon bearings *h*, *h*, and acted upon by the depression of the finger keys *b*. The stop plates carry fixed levers or arms *i*, *i*, to the extremities of which are attached the ratchet leaves *k*, *k*, working into the pinion *l* fixed upon the other extremity of the axis *e*. The stop plates *g*, *g*, are sufficiently broad to allow several of the finger keys or buttons *b*, *b*, separately to press upon each of them. The lower part of each key is furnished with a pin *m*. These pins are radially arranged from each key towards the centre, the axis carrying the index *f* is also furnished with an arm or stop *n* placed below the plane of the pins attached to the keys. On pressing down a key or button the stop plate *g* is acted upon and carries forward the arm *i*, *i*, and ratchet *k*, this pressing on to the pinion *l* by means of a spring *p* causes the axis and consequently the index to rotate until the stop *n* on the axis comes against the pin *m* of the depressed key, and thus the motion is arrested when the index is opposite to the letter corresponding to the depressed key; when the finger key or button is released the ratchet recedes by means of the spring *r* to its original position. Motion is communicated to an apparatus *s* for alternately inverting the current, similar to that of the communicator already mentioned as the first improvement, by means of the toothed wheel and gearing *t* attached to the axis *e*. The pin *w* upon the arm *n* is for the purpose of throwing the line to earth by contact with the movement and connections *x* when the appropriate button or finger stop is depressed.

The third improvement consists in a new construction of the magneto-electric machine. Two soft iron or hard steel cores, with their coils, are fixed to each pole of a permanent magnet, so that the centres of their unfixed ends are equidistant from each other in the circumference of a circle. An axis passing through the centre of this circle carries a soft iron armature, the breadth of which is a little greater than the distance between two adjacent cores. The wires of the coils are so connected together that the currents produced simultaneously in each coil, two by the approach and two by the recession of the armature to and from the soft iron or hard steel cores, all concur to produce a current in the same direction in the communicating wire, and during one revolution of the armature four shocks, or instantaneous currents are successively produced at equal intervals, each successive shock being in the opposite direction to the preceeding. Several magnets of this description may be combined to form a compound magneto-electric machine. The magnets are placed so that the axis carrying the armatures are vertical, and arranged at equal distances in a circle; each of these axis is furnished

with a pinion, and all the pinions gear into a wheel fixed on an axis, which is connected by means of multiplying wheels with the handle. The position of the armatures may be so varied that the shocks produced by all the magnets may be simultaneous, or they may be successive; thus, when the machine is composed of four magnets, according to different arrangements of the positions of the armatures, four, eight, or sixteen currents may be obtained during one revolution of the central axis.

Figure 6 is a plan, and Figure 7 an elevation, (Sheet 1,) of a magneto-electric machine constructed according to this improvement. *a*, *a*, and *b*, *b*, are two soft iron or hard steel cores fixed to each pole of a permanent magnet, so that the centres of their unfixed ends are equidistant from each other in the circumference of a circle. *c*, *c*, and *d*, *d*, are the coils surrounding these soft iron or hard steel cores; *e* is an axis passing through the centre of this circle, and carrying the soft iron armature *f*, the breadth of which is a little greater than the distance between two adjacent cores. The wires of the coils *c*, *c*, and *d*, *d*, are so connected together that the currents produced simultaneously in each coil, two by the approach and two by the recession of the armature *f* to and from the soft iron or hard steel cores *a*, *a*, and *b*, *b*, all concur to produce a current in the same direction in the communicating wire, and during one revolution of the armature *f*, four shocks or instantaneous currents are successively produced at equal intervals, each successive shock being in the opposite direction to the preceeding, but the principle adopted in the preceeding improvement may be also introduced in this arrangement.

Figure 1 is a plan, and Figure 2 an elevation, (Sheet 2,) of a magneto-electric machine, in which several magnets are combined to form a compound apparatus. The magnets *a*, *b*, *c*, are placed so that the axes *d*, *e*, *f*, carrying the armatures *g*, are vertical, and arranged at equal distances in a circle. In the Drawing each pole of the magnet is shown with only one soft iron or hard steel core attached, instead of two, as above described. Each of these axes is furnished with a pinion *h*, and all the pinions gear into a wheel *k* fixed on an axis *l*, which is connected by means of multiplying wheels with the handle. The position of the armatures *g* may be so varied that the shocks produced by all the magnets may be simultaneous, or they may be successive; thus, when the machine is composed of four magnets, according to different arrangements of the positions of the armatures, four, eight, or sixteen currents may be obtained during one revolution of the central axis.

The fourth improvement consists in substituting for a voltaic battery a magneto-electric machine, either simple or compound (that is, either consisting of one or of several magnets and armatures) kept in continual motion by the

action of a constant force, for the purpose of ringing any number of electro-magnetic bells anywhere placed in an establishment. For this object one end of the magneto-electric coil is placed in connection with the earth, from any points of a conducting wire attached to the other end of the coil wires proceed to the touches or connecting apparatuses of all the bells; other wires also proceed from the touches to a conducting wire immediately connected with the earth. When the touch corresponding to any bell is acted upon, its two wires are brought into contact, the circuit is thereby completed through the branch containing the bell, the magneto-electric current circulates, and the bell rings. It will be found in some cases more convenient to suppress the earth communications, and to join the two main conducting wires at their extremities; in this case the circuit, when formed, will be entirely metallic.

Figure 3 (Sheet 2) shews the general arrangement of a magneto-electric machine and connections according to this improvement, for the purpose of ringing any number of electro-magnetic bells anywhere placed in an establishment. *a*, *a*, are the electro-magnetic bells; *b*, *b*, the touches corresponding to the several bells, and connected with them by the metallic circuits *c*, *c*; *d*, *d*, are the keys for acting upon the touches, and in connection with the earth at *e*. The electro-magnetic bells are placed in circuit with the magneto-electric machine by the wire *f*; the other end of the coil wires is connected with the earth at *g*. When the key *d* of any touch corresponding to any bell is acted upon its two wires are brought into contact, the circuit is thereby completed through the branch containing the bell, the magneto-electric current circulates, and the bell rings. When it is found more convenient to suppress the earth communication, the two main conducting wires *e* and *g* may be joined at their extremities; in this case the circuit, when formed, will be entirely metallic. Any magneto-electric machine may be employed for this purpose.

In the apparatus represented by the Drawing, Figure 3, the six horse-shoe magnets, with their coils, are fixed, while the central axis carrying the armatures revolves, the poles of all the magnets are arranged in a circle round this axis; the disposition of the Figure does not allow the other branches of the magnets with their coils to be seen. The soft iron armatures on the axis are of sufficient length to cover the two poles of each magnet. This Figure is introduced for the purpose of shewing another arrangement of a compound magneto-electric machine with coils and soft iron cores attached to the poles of the fixed magnets differing from that described in the fourth improvement.

The fifth improvement is a magneto-electric apparatus for ringing an electro-

magnetic bell at a distance, so constructed, that a single motion of a lever, or a single pull of a rope or wire, causes several currents to be produced in succession, in order to act repeatedly on the electro-magnet moving the clapper of a bell, or the detent of the alarum described as the eleventh improvement in the Specification of the Patent No. 1241, granted to me on June the 2nd, 1858. The lever is connected with the rotating armature of the magneto-electric machine, by means of a chain or band, which causes it to make several revolutions by a single motion of the lever, and a spring reverses the motion immediately the armature ceases to act.

Figure 4 (Sheet 2) is an elevation, and Figure 5 a plan of a magneto-electric apparatus constructed according to this improvement.

a is the axle carrying the armature *b*; *c* is the magnet; *d* is a spring attached to the axle *a* for reversing the motion immediately the armature ceases to act; *e* is a chain or band round the axle *a*, one end of the chain being attached to the arm *f* in connection with the handle or pull *g*. Upon depressing the handle, the arm *f* extends the chain or band from off the axle *a*, and causes the armature *b* to rotate over the poles of the magnet; the spring *d* reversing the motion immediately the lever *g* is relieved.

Figure 6 shows an arrangement whereby any one of several bells can be thrown into circuit with the magneto-electric apparatus at pleasure.

The sixth improvement consists in the employment of musical pipes or free tongues, (such as employed in the concertina, harmonium, and other such musical instruments) acted upon by wind, for the purpose of communicating intelligence by means of audible instead of visible signs. I prefer to employ pipes or tongues producing very high sounds, since they require a much less quantity of wind than lower sounds. The passage between the reservoir of air, and the pipe or tongue is closed by a valve, which when acted upon by an electro-magnet, opens and allows the passage of the wind to the pipe or tongue. The reservoir of air may be either a small gasometer, a water blow-pipe, an india-rubber ball, collapsing by its own elasticity, or a bag impermeable to air, compressed by a weight or spring; the air being in all these cases restored, when exhausted, by blowing through a pipe furnished with a throttle valve, or by other means; or, a bellows of any description kept in action by a maintaining power, may be employed for this purpose. With this apparatus long and short sounds may be made to follow each other in the succession constituting the letters of Morse's telegraph. Two such pipes or tongues producing different notes, connected with the same or separate reservoirs; the valve of one acted upon when the current proceeds in one direction, and the valve of

the other when the current proceeds in the opposite direction, constitutes a telephone, of which the alphabet may correspond with that of the usual single needle telegraph.

Figure 7 (Sheet 2) represents an apparatus constructed according to this improvement.

a represents the four poles of two small electro-magnets with a magnetic armature or needle working upon the centre *f*; *b* is the musical pipe or free tongue connected with the air chest *c*, a flexible tube or channel *d* from the air chest completes the communication with the gasometer, or air reservoir, the emission of the gas or air through the pipe or tongue, being regulated at the proper intervals by the action of the arm *e* and pallet movement *g*, attached to the centre of motion *f*, of the magnetic armature or needle of the electro-magnetic arrangement. The necessary succession of currents to act upon the electro-magnetic arrangement may be obtained either by means of an ordinary Morse key placed anywhere in circuit with a voltaic battery or from a magneto-electric machine, the currents of which are developed by the pressure of a lever or key causing the movement of an armature from a magnet. Instead of compressed air, I prefer the employment of common gas for that purpose, when such is to be obtained, a simple communication with the meter being all that is required to produce a clear and sonorous quality of sound. In such case a provision must be made to allow of the proper escape of the gas by combustion or other means, which may be effected in a variety of obvious ways.

The seventh improvement is a modification of that part of my automatic printing telegraph, which is called the transmitter, and is described as the second improvement in the Specification of the Patent No. 1239, granted to me and dated June 2nd, 1858. The object of this modification is to enable the transmitter, by means of the perforated slips of paper therein described, to act upon the receiving instrument of a Morse's telegraph, in such manner as to impress on bands of paper in any required order, the successions of long and short marks in the same line which constitute the alphabet of that telegraph, instead of the double row of dots required in my system. For this purpose a slight change only in the mechanism already described is necessary. The contacts made by the external wires of the rocking frame are so disposed, that whether one or the other be depressed, the current is transmitted to the telegraphic wire in the same direction, instead of in opposite directions, as in the case of the former construction. The eccentric which effects the elevation and depression of the wires acts differently upon them, so that the duration

of the contact of one wire lasts longer than that of the other. When the slip of perforated paper is inserted in the groove of the rocking frame of the transmitter, and the instrument is put in action, whenever the end of one of the wires enters an aperture in its corresponding row the current has a shorter duration, and whenever the end of the other wire enters an aperture of the other row, it has a longer duration. By the appropriate arrangement of apertures in the slip of paper, long and short currents are thereby made to succeed each other in the proper order to mark on the recording or receiving instrument the letters of what is termed the Morse alphabet.

Figures 8 and 9 (Sheet 2) are a side view and elevation of a portion of a transmitter constructed according to this improvement. *a* is the eccentric axis carried in the frame of the transmitter, and caused to revolve by suitable machinery; *l*, *m*, and *n* are the three needles passing through holes in the top of the rocking frame, and terminating at their lower extremities in hooks which pass round the eccentric axis *a*. The hooks of these needles are kept up in contact with the axis by the spiral springs *o*, *p*, and *q* respectively. The two outside needles are furnished with pins *r* and *s*, which serve for the passage of the electric currents or shocks, as will be hereafter explained; they are in metallic communication with the line wire through the frame of the apparatus. *b* is a piece of metal insulated from the frame of the transmitter by the ivory bosses *c* and *d*. This piece of metal is in metallic communication with one pole of the battery or other apparatus producing the electric currents or shocks by means of the pin *e* and wire *f*. The pin *e* carries the spring *g*. Two metal arms *h* and *i*, working upon centres, are attached to the insulated piece *b*, and acted upon by the springs *j* and *k* in contrary directions, the arm *h* being pressed upwards against the stop pin *t* and the cam *i* in a downward direction, so as to bring one end in contact with *h*. The arm *h* has a slight lateral slot-movement on its centre. *u* is an insulating piece of ivory working loose on a centre attached to the metal piece *b*. This piece of ivory is furnished with a pin *v*, in metallic communication with the earth through the coil spring *w*, the ivory piece *u* being pressed against the pin *x* attached to the arm *h*. It will be seen that each time that the crank axis *a* revolves, it takes down with it all the three needles *l*, *m*, and *n*, and that when the crank moves to its highest position the needles rise with it (unless some impediment be interposed, the needles *l* and *n* being drawn up by the springs *o* and *q*, and the needle *m* by the spring *p*; and in addition to the rising and falling motion of the needles, the crank causes them to have a rocking upon the pivoted frame *y*. When

the apparatus is in action, the slip of paper, punctured as described in the first claim of my Patent, No. 1239, granted to me, and dated June 2nd, 1858, is placed between the guides, that each time the needles *l* and *n* are allowed to rise, one of them enters a perforation in the slip of paper, and passes the current by metallic contact between the line and the apparatus producing the electric currents or shocks, the duration of the current being regulated in the following manner:—When the needle *n* enters a perforation in the paper, it rises by force of the spring *g* with the revolution of the crank axis *a*, making a momentary contact at its greatest elevation for the passage of the current between the spring *g* and the pin *s*, thereby causing a dot to be registered at the distant recording apparatus. Immediately after the passing of the current the line is discharged to earth by the temporary contact of the pin *r* with *v* in the completion of the revolution of the crank axle *a*. When the needle *l*, for producing the long current or dash in the Morse alphabet, enters a perforation in the slip of paper, the revolution of the crank axis *a* causes the pin *r* to enter a notch at the extremity of the arm *h*, the contact being maintained by the pressure of the spring *j* on the slotted bearing until, in the revolution of the crank axis *a*, the pressure of the descending arm *h* causes the other arm *i* to rise, and at the half revolution to catch the pin *r* upon its release from *h*, prolonging the duration of the contact and passage of the current. During the contact with the arm *h* the pin *x* has in its motion depressed the earth connection *v*, which is therefore in position upon the release of *r* from *i*, to make the momentary discharge of the line into earth, thus according as one or other of the needles *l* and *n* is allowed to rise by the perforations in the strip of paper, so will the battery or other source of electric power be brought into the circuit, so as to communicate in the same direction shocks or currents of long or short duration in the proper order to mark on the recording or receiving instrument the letters of what is termed the Morse alphabet.

The eighth improvement is a telegraphic thermometer, which communicates to a distant place notice of the two limits of its indications. Its construction is as follows:—A segment of a circle graduated so as to include the two limits of temperature intended to be indicated is fixed on an insulating board. Two arms move separately round a pin at the centre of the circle, the longer ends of these arms serve as pointers to be set at the required degrees of the graduated circle, the shorter ends carry pins in which adjusting screws are inserted. A compound metallic bar consisting of long strips of iron and brass, or other two dissimilar metals soldered together face to face is fixed at one

end to the board, so that its edge is perpendicular thereto, the free end of this bar is placed between the pins on the shorter ends of the arms, and the distances of the latter are so adjusted by means of screws, that when the extremes of temperature to which the arms are set act upon the compound bar it shall come in contact with one of them. A binding screw is in communication with the metallic arms of the circle, and another with the fixed end of the compound bar. The terminals of a voltaic circuit, including a voltaic battery and an electro-magnetic bell, are attached to the two binding screws. So long as the unfixed end of the compound bar is entirely free the circuit remains open, but when the action of temperature brings it into contact with either pin, the circuit is completed, the voltaic battery is brought into activity, and the bell rings. Instead of a straight bar, a compound bar formed into a helix, as in Breguet's metallic thermometer, and carrying at its unfixed end a pointer may be substituted, pins moveable for the purpose of being set at determinate degrees are placed on the graduated circle, and the contact of the pointer with either of these pins determinates the completion of the circuit.

Figure 10 (Sheet 2) is an apparatus constructed according to this improvement. *a* is a segment of a circle graduated, so as to include the two limits of temperature intended to be indicated; *b* is an insulating board to which it is affixed. Two arms *c* and *d* move separately round a pin *e* at the centre of the circle, the longer ends of these arms serve as pointers to be set at the required degrees of the graduated circle, the shorter ends carry pins *f*, *f*, in which adjusting screws are inserted. A compound metallic bar *g* consisting of long strips of iron and brass or other two dissimilar metals soldered together face to face is fixed at one end to the board, so that its edge is perpendicular thereto, the free end of this bar is placed between the pins on the shorter ends of the arms, and the distances of the latter are so adjusted by means of the screws, that when the extremes of temperature to which the arms *c* and *d* are set, act upon the compound bar, it shall come in contact with one of them. A binding screw *h* is in communication with the metallic arms of the circle, and another binding screw *i* with the fixed end of the compound bar. The terminals of a voltaic circuit, including a voltaic battery and an electro-magnetic bell, are attached to the two binding screws. So long as the unfixed end of the compound bar is entirely free, the circuit remains open, but when the action of temperature brings it into contact with either pin, the circuit is completed, the voltaic battery is brought into activity and the bell rings. Instead of a straight bar, a compound bar formed into a helix, as in Breguet's metallic thermometer, and carrying at its unfixed end a pointer, may be

substituted, pins moveable for the purpose of being set at determinate degrees are placed on the graduated circle, and the contact of the pointer with either of these pins determines the completion of the circuit.

The ninth improvement consists of a new system of establishing lines of telegraphic communication over the houses or along the streets of cities, towns, and other places. At present naked iron or steel wires are stretched between posts at certain distances apart supplied with straining apparatus, and intermediate posts are placed for supporting while preserving the insulation of the wires. The chief disadvantages of this system are, first the great expense when the number of wires is considerable, second, the great danger of contacts between wires which cross each other in various directions; and, third, the liability to loss of insulation in wet weather. In the proposed system straining posts elevated at the tops of public buildings or private houses are fixed at distances about a mile apart, and their positions are so arranged that when they are joined by straight lines, a series of triangles as nearly approaching equilateral as may be found convenient, is mapped out. From these straining posts in six different directions nearly equidistant from each other, two steel or galvanized iron wires are stretched in the same horizontal plane to all the posts about a mile distant from it, and their tension is maintained by straining apparatus. A single strong wire will suffice, but greater security will be ensured by employing two. Intermediate supporting posts, but which require no insulating apparatus, as these wires are not for the purpose of transmitting electricity, are fixed at convenient distances. A rope consisting of a bundle of metallic wires (say from twenty to sixty) each having a separate covering of india-rubber, gutta percha, or other good insulating material is suspended from these two wires at short intervals along their entire lengths. The ropes terminate at the straining posts, and the free ends of all the wires contained therein are brought into a box, which forms part of or is placed in connection with the posts; by means of metallic connections within the box, the wires proceeding from one direction may be united to those proceeding in any other, and thus the wires may be combined in every possible manner, and the combinations changed as required. From these connecting stations also the single wires proceed, which complete the communication between the main lines and the establishments to be placed in connection with them. It is not necessary to cover the whole of a town with triangulations, as above described, they may be extended only to those parts of the town where telegraphic communication will be profitable, and they may also be intermitted where other means of carrying the rope may be more convenient or economical. Figure 14 (Sheet 3) represents a portion of a city or town triangulated in the manner described. *a*, *a*, are

the drawpost stations situated at the intersections of the various lines; *b*, *b*, the lines of insulated wires united at the posts *a*, *a*. The dotted lines represent districts of the town to which the system of triangulation may be extended. In particular cases the following methods of suspending the rope of wires will be found advantageous:—First, iron posts of considerable elevation are to be erected in the streets in positions ordinarily occupied by lamp posts. These are for the purpose of staining and supporting two steel or iron wires, as in the first method, and the rope of wires is to be suspended from them in a similar manner. When two or more streets intersect each other, and it is necessary that lines should proceed through several or all of them, the ends of all the ropes terminating at that post must pass down it, so that the wires contained in them may be there connected in any way that may be required. Figure 13 (Sheet 3) is an elevation of the wire rope, supported according to this method. *a*, *a*, are the posts of considerable elevation erected at convenient distances in the street; *b* is the insulated wire rope passing between them. Second, iron rods or wires are laid at convenient distances from each other transversely across streets, so that the ends of each shall be fixed on the top or against the front wall of houses opposite each other. Each of these rods or wires is furnished with a ring or eye fixed to some part of its length, where it passes over the street, and the rope containing the insulated telegraphic wires passes through these rings or eyes. To diminish the swag of the rope a tightening screw is adapted to each suspending ring for the purpose of grasping it. When it is required to form a connecting station, the transverse rod or wire must be provided with two or more rings or eyes to receive the ropes proceeding from different directions. The ends of all the ropes must be led along the rod, and thence into a room of an adjacent house; or they may be led down covered by a protecting tube outside the house to a connecting box placed against the wall. It will be more advantageous for many obvious reasons to conduct the telegraphic line, when this method is adopted, through narrow streets than through the leading thoroughfares. The common feature in all these methods is that of supporting ropes each containing a number of insulated wires in the air along streets or over the roofs of houses, and so bringing the ends of the wires belonging to a rope proceeding from one direction in juxtaposition with those proceeding from other directions that they may be combined to form continuous lengths through a variety of different routes, so as to be capable of forming an uninterrupted communication in several ways from any one point to another in the system.

Sheet 3, Figures 1 and 2, represent an elevation of two methods of establishing lines of telegraphic communication. According to this improvement,

a, Figure 1 is one of the straining posts elevated at the top of public buldings or private houses, and fixed at distances about a mile apart, and their positions are so arranged that when they are joined by straight lines a series of triangles as nearly approaching equilateral as may be found convenient is mapped out. From these straining posts in six different directions, nearly equidistant from each other, two steel or galvanized iron wires *c* are stretched in the same horizontal plane to all the posts about a mile distant from it, and their tension is maintained by straining apparatus *b*; a single strong wire will suffice, but greater security will be ensured by employing two. Intermediate supporting posts *d* (but which require no insulating apparatus, as these wires are not for the purpose of transmitting electricity) are fixed at convenient distances. A rope *e* consisting of a bundle of metallic wires (say from twenty to sixty) shown in longitudinal section at Figures 4, and transverse section at Figure 6, each having a separate covering of india-rubber, gutta percha, or other good insulating material is suspended from these two wires at short intervals along their entire lengths by apparatus *f*, Figure 7.

Figure 2 represents another mode of suspending the rope containing the insulated conducting wires from post to post, by means of a central straining wire *g* shown in section at Figures 3 and 5, and in elevation at Figure 2. In this case the external straining wires *c* and apparatus *f* are dispensed with, the ropes terminate at the straining posts, and the free ends of all the wires contained therein are brought into a box *h*, Figure 1, which forms part of or is placed in connection with the post. Figure 8 is an interior elevation of a box of this description, and Figure 9 a transverse section. *e* the ropes of metallic conductors entering the box, and by means of the insulated metallic connections *n* within the box the wires proceeding from one direction may be united to those proceeding in any other, and thus the wires may be combined in every possible manner, and the combinations changed as required.

Figures 10 and 11 is a plan and elevation of another form of insulating apparatus for connecting the ends of the wires together when divided at intervals along the main line for testing and other purposes; the ends of the wires being severally carried through insulating tubes numbered respectively to correspond with those upon the metallic connections *n* within the box *h*. One set of the tubes in these connecting discs are coloured to distinguish the coming in wires from the exit wires. From these connecting stations also the single wires *m* proceed. which complete the communication between the main lines and the establishments to be placed in connection with them.

Figure 12 is a plan of the straining apparatus of one of the posts *a* according to this improvement. It is not necessary in all cases that six ropes, with their

respective suspending wires, should proceed from each straining post, a less or greater number may be fixed thereto according to the requirements of the neighbourhood.

The tenth improvement is a method of constructing the supports of suspended telegraphic wires, which has the advantage of preventing in a great measure the communication of sound and vibratory motions arising from the action of wind; this object is effected by interposing a cylinder of vulcanized india-rubber between the support and the insulating apparatus of the telegraphic wires. This method is equally applicable to the suspending wires carrying the rope of conductors described in the preceeding article, but in this case no insulations are required.

Figure 9, Sheet 1, is an elevation of the supports of suspended telegraphic wires according to this improvement. *a* is a portion of the post; *b*, *b*, are the telegraphic wires; *c*, *c*, are rings of vulcanized india-rubber placed between the post and the wire; *d* is a metal washer exterior to the vulcanized india-rubber, round which the telegraphic wire *b* is secured; *e* is a tube of ebonite or other insulating material for the protection of the wire at the point of contact with the post.

The eleventh improvement consists of a method of augmenting the shocks of a magneto-electro machine, forming part of the communicator of an electro-magnetic telegraph. This is effected by causing by means of suitable apparatus a short circuit, including the magneto-electric coil to be complete, the instant after the shock is thrown open into the telegraphic circuit without breaking the continuity of the latter.

Figure 2 (Sheet 2) is a plan, and Figure 1 an elevation of an apparatus constructed according to this improvement. *s* is an insulated piece of metal attached to the axle of the pinion *h* carrying the armature *g*. The two metal springs *m* and *n* are respectively attached to the earth and line wires; the spring *m* rubbing against the metallic cross piece *s*, and the spring *n* being so adjusted by means of the screw *t* as to make a momentary contact with *s* during its rotation. It will, therefore, be seen, that the moment of contact can be so arranged as to occur the instant after the armature *g* has broken contact with the poles of the magnet, throwing the shock open into the telegraphic circuit, the short circuit between *u* and *v* being completed without breaking their continuity.

Having thus described the nature of my said Inventions, and the manner of performing the same, I would have it understood that I do not confine myself to the exact details described, as the mechanical details may be much varied without departing from my Invention; what I claim is,—

First, the modification of the communicator with finger keys, described as the sixth improvement of my Patent, dated June 2nd 1858, No. 1241, in which an apparatus for alternately inverting the currents of a voltaic battery is substituted for a magneto-electric machine, as there represented; and I make this claim, whether the direct currents of the voltaic battery, or the induction currents generated in a secondary coil are communicated to the telegraphic circuit. And I also claim the method of constructing an apparatus for alternately inverting the currents of a voltaic battery in which pressing contacts are substituted for the rubbing contacts previously employed; which apparatus may form part of a communicator with finger keys, or of one with a revolving handle or letter circle.

Second, the method or methods of constructing a communicator for the purpose of working a step-by-step alphabetic telegraph, in which the proper number of currents from a voltaic battery necessary to make any letter appear in the telegraphic receiving instrument is determined solely by the pressure of a corresponding key. And I claim this method whether the current has to be alternately inverted or simply interrupted, or whether primary or induction currents are employed.

Third, the method of constructing a magneto-electric machine described as the third improvement, in which a soft iron armature revolves before a horse-shoe, or other magnet with bifurcated poles, made either of iron or steel, and round which poles insulated wire is wound. When a soft iron armature revolves before the two poles of a horse-shoe magnet with stationary coils, four currents are generated in the coils during one revolution, which currents are alternately in opposite directions, but are unequal in intensity, and do not succeed each other at equal intervals. By the construction described in the aforesaid third improvement, the alternate currents are caused to succeed each other with equal intensity, and at regular intervals, the effecting of which important improvement I especially claim. This construction of a magneto-electric machine is equally applicable to the communicator of a step-by-step alphabetic telegraph, or to the transmitter of an automatic printing telegraph.

Fourth, the employment of a magneto-electric machine, whether simple or compound, the armature or armatures of which are kept in continual motion by any maintaining power, for the purpose of being substituted for a voltaic battery in connection with a system of electro-magnetic bells in an establishment. I also claim the arrangement of several magnets with fixed coils surrounding the poles thereof, whether of soft iron or hard steel, into a compound magneto-electric machine, as shewn in Figures 1, 2, and 3, Sheet 2, and described under the third and fourth improvements. All

previous compound magneto-electric machines, except one described in the eighth improvement of my Patent dated 2nd June 1858, No. 1241, have been constructed with moving instead of stationary coils.

Fifth, the method of constructing a magneto-electric machine in which several successive shocks or currents are produced by means of a single motion of a lever, whether the motion be communicated from the lever to the armature by means of a chain or band, or wheels geared into each other.

Sixth, the employment of musical pipes or free tongues acted upon by wind in the construction of telephones, in which the alternation of long and short sounds are grouped in a similar manner to the long and short lines in the alphabet of a Morse's telegraph; or in which two sounds are made to succeed in the order of the alternate motions which constitute the alphabet of a single needle telegraph.

Seventh, the modifying of the transmitter of my automatic printing telegraph, (described as the second improvement of my Patent dated June 2nd 1858, No. 1239,) so as to enable it to act upon the receiver of a Morse's telegraph, in order to impress or print the long and short lines, the various groupings of which constitute an alphabet.

Eighth, the method of constructing a metallic telegraphic thermometer, by means of which two limits of temperature are indicated.

Ninth, for suspending a rope containing several insulated wires from a wire or wires stretched between supports placed at suitable distances, in order to support the rope containing the wires without subjecting the wires therein to any stretching force. Also for placing in the centre of a rope containing a number of insulated wires a wire composed of one or more strands of iron, steel, or other suitable metal, for the purpose of being stretched between supports placed at suitable distances. Also for suspending the rope containing the insulated wires over streets in the direction of their length, from transverse rods or wires fixed to houses opposite each other. Also for the regular or irregular triangular arrangement of the telegraphic ropes, by which several ropes abut on each straining post, and extend from one straining post to another without the necessity of crossing each other. Also for bringing to the same stretching post a number of ropes containing insulated wires, in such manner that the ends of these wires are, by an appropriate apparatus, combined in a variety of ways to divert the electric current from one channel to another.

Also for placing at the supporting posts, intermediate between the straining posts, an apparatus, by means of which the wires may be connected or disconnected at pleasure, so that they may continue uninterrupted from one straining post to another, or branch off to any special station.

Tenth, for a method, of constructing the supports of suspended telegraphic wires, which has the advantage of preventing in a great measure the communication of sound and vibratory motions arising from the action of wind.

Eleventh, for a method of augmenting the shocks of a magneto-electro machine forming part of the communicator of an electro-magnetic telegraph, by means of suitable apparatus causing a short circuit, including the magneto-electric coil, to be completed the instant after the shock is thrown open into the telegraphic circuit without breaking the continuity of the latter, which may be used either with or without the introduction of a condenser between the circuit wires.

In witness whereof, I, the said Charles Wheatstone, have hereunto set my hand and seal, this the Ninth day of April, in the year of our Lord One thousand eight hundred and sixty-one.

CHARLES WHEATSTONE. (L.S.)

Witness,

NATHANIEL J. HOLMES.

LONDON:
Printed by GEORGE EDWARD EYRE and WILLIAM SPOTTISWOODE,
Printers to the Queen's most Excellent Majesty. 1861.

A.D. 1860. Oct. 10. No 2462.
WHEATSTONE'S SPECIFICATION.

(3 SHEETS)
SHEET 1.

FIG. 8.

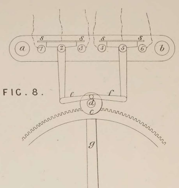


FIG. 5.

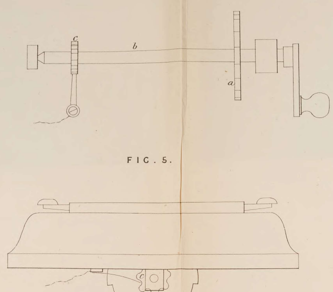


FIG. 4.

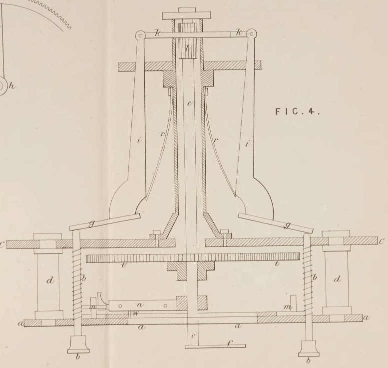


FIG. 1.

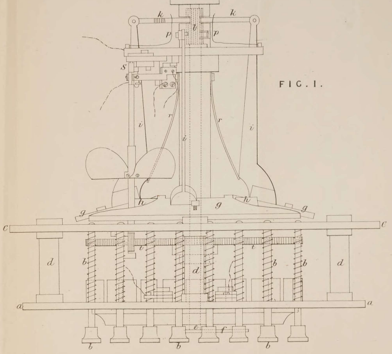


FIG. 6.

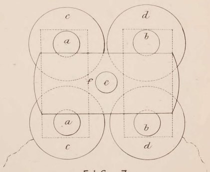


FIG. 7.

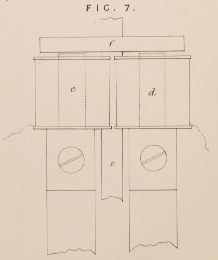


FIG. 3.

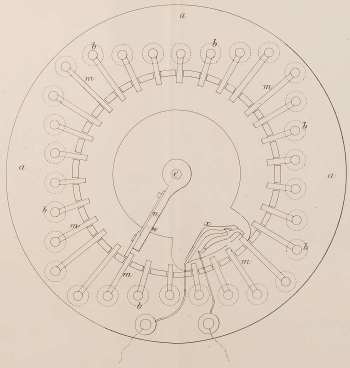


FIG. 9.

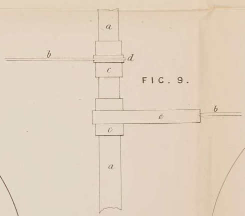
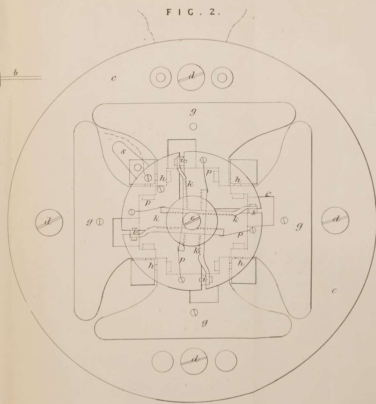


FIG. 2.



The filed drawing is partly colored.

Drawn on Stone by Malby & Sons

LONDON: Printed by George Edward Eyre and William Spottiswoode, Printers to the Queen's most Excellent Majesty. 1861.

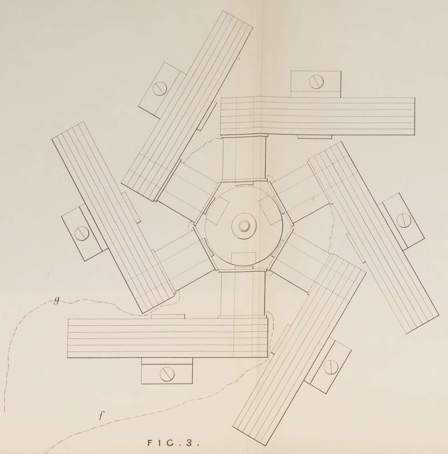
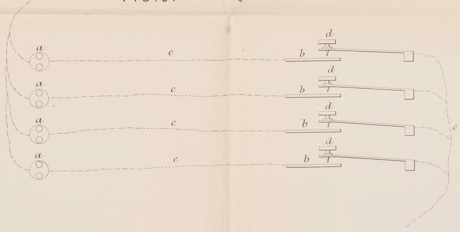


FIG. 3.



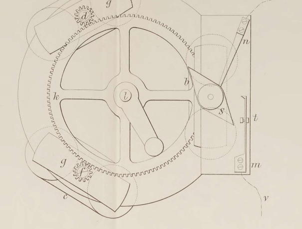


FIG. 2.

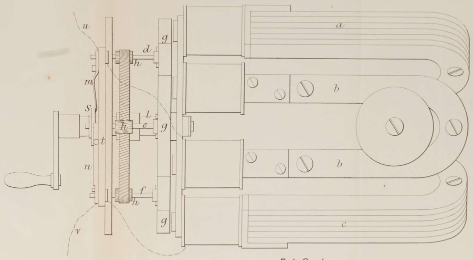


FIG. 1.

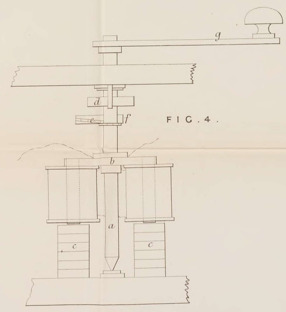


FIG. 4.

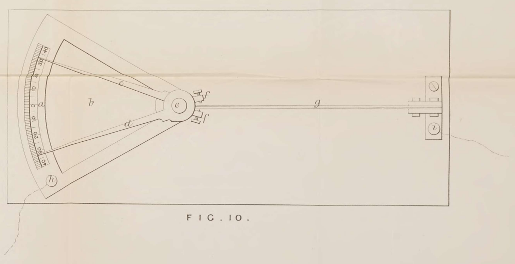


FIG. 10.

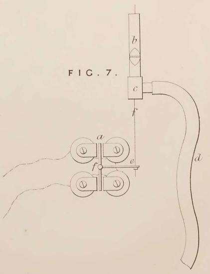


FIG. 7.

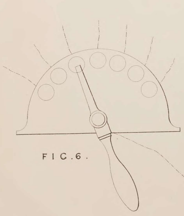


FIG. 6.

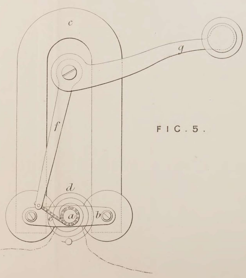


FIG. 5.

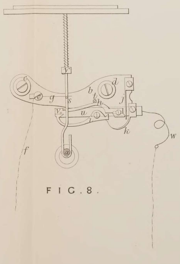


FIG. 8.

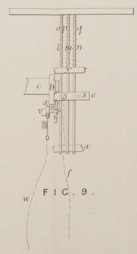


FIG. 9.

The filed drawing is colored.

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FIG. 2.

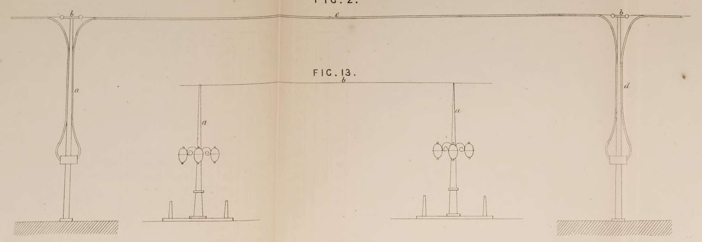


FIG. 13.

FIG. 1.

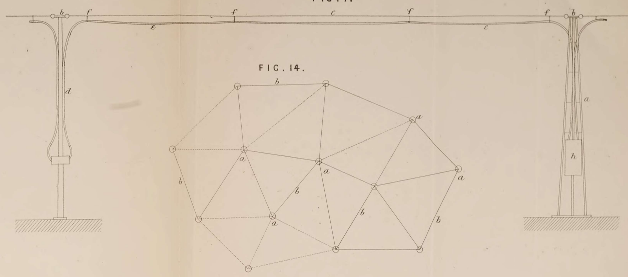


FIG. 14.

FIG. 7.

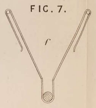


FIG. 9.

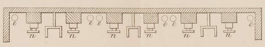


FIG. 3.

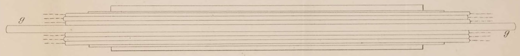


FIG. 8.

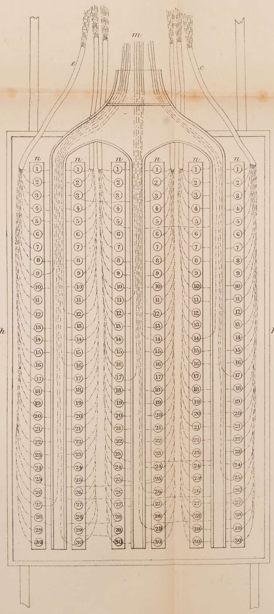


FIG. 12.

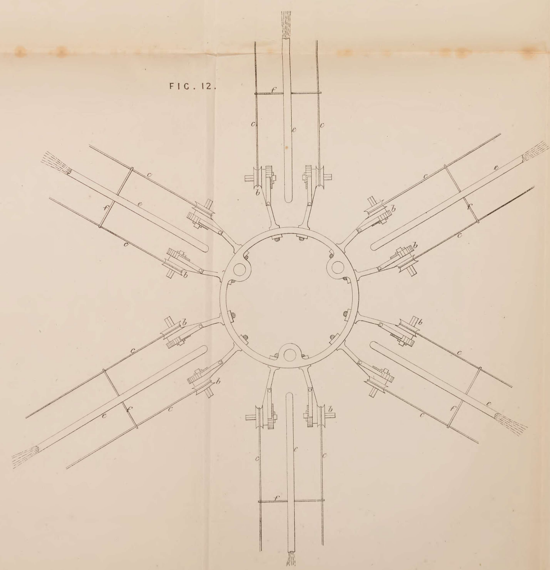


FIG. 4

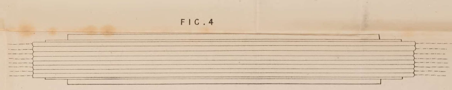


FIG. 5.



FIG. 6.



FIG. 10.

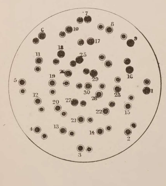
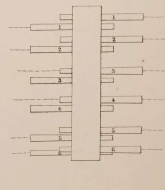


FIG. 11.



The filed drawing is colored.

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